



## STRATUS CONSULTING

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Expert Report for State of Oklahoma, in Case No.  
05-CV-0329-GKF-SAJ, State of Oklahoma v. Tyson  
Foods, et al. (In the United States District Court for the  
Northern District of Oklahoma)

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Benefits transfer is commonly used in economics, and there is a well-developed scientific literature on the topic (Rosenberger and Loomis, 2003). Guidelines for economic analysis discuss how and when benefits transfer should be applied (U.S. EPA, 2000; U.S. OMB, 2003).

The benefit transfers approach is recognized as an appropriate assessment method in federal natural resource damage assessment regulations [U.S. Department of the Interior (DOI) 43, C.F.R. Part 11, 61 FR 20560, 73 FR 57259, the National Oceanic Atmospheric Administration (NOAA) 15 C.F.R. Part 990 61 FR 440] and benefit transfer studies have formed the basis of damage calculations in previous natural resource damage assessments and other court cases [e.g., *California v. B.P America, (S/V American Trader)*; *Alaska Pulp Corporation v. United States*]

In the present case, we adapt the estimate of average willingness-to-pay (WTP) per household in 2008 for reducing future injuries occurring after 2008, as reported in Chapman et al. (2009), in order to estimate the average WTP per household in 1980 for reducing injuries occurring between 1981 and 2008.

In evaluating the applicability of the estimate from Chapman et al. (2009) for a benefits transfer, we note that: the geographic location is the same; the same environmental resources are being evaluated with respect to the same types of injuries; and the population groups are similar. Below, we compare the characteristics of the population groups including incomes and attitudes towards spending on the environment to account for potential change in those variables.

## Estimating Past Damages

The objective is to estimate the economic value of the loss of services arising from injuries to Oklahoma public trust resources in the Illinois River system and Tenkiller Lake occurring during the period 1981-2008. This valuation is based on the estimate of average WTP of \$184.55 per household in the Oklahoma study area, measured in 2008 dollars (Chapman et al., 2009). That single payment estimates the tradeoff an average household made in 2008 to avoid the combined loss of services from injuries in the Illinois River system and Tenkiller Lake occurring between 2009 and 2058 (for the Illinois River system) and between 2009 and 2068 (for Tenkiller Lake). This is being adapted to estimate the tradeoff that an average household would have made in 1980 to avoid a loss of services from injuries in the Illinois River system and Tenkiller Lake occurring between 1981 and 2008.

It is not possible to apportion the \$184.55 from the contingent valuation (CV) study into separate values for the river and the lake, or into a separate value for the loss of services in any particular year. Each respondent to the CV survey made an overall assessment of whether the program for the accelerated reduction of injuries in the river and lake over these periods was worth at least the specified cost when deciding whether to vote for or

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against the program. Different respondents could have evaluated the conditions in the river and the lake differently, as well as the plan and its implications for each resource. We do not know how each person aggregated the individual years' losses of services. In thinking about the program, some respondents may have discounted the future reductions in injuries as a result of the program, and others may not. Those who did discount future reductions in injuries may have applied different discount rates for this purpose. These are some of the variations that underlie the variation in voting responses and are implicit in the probabilistic formulation of a WTP distribution (see Chapman et al., 2009, Section 7.1).

In the CV survey, respondents valued a program to reduce injuries occurring in the river system through 2058 and in the lake through 2068. Chapman et al. (2009) used the tradeoff that respondents made to estimate a value for the change in the flows of services occurring during those periods of time. For simplicity, suppose respondents were assessing a change in services 55 years into the future, occurring between 2009 and 2063. (The year 2063 is selected here as the mid-point of the years for the recovery of the river and the lake.) The relevant question for the benefits transfer is: How might the choice about a plan in 2008 compare with the choice about a similar plan in 1980 looking forward in time at injuries beginning in 1981 and ending in 2008 (28 years)? The two choices could differ for several reasons. First, the time periods are different: 28 years versus 55 years. Second, the year-to-year injuries could be different between the two time periods. The analyses by Engel (2008a, 2008b, 2008c), Stevenson (2008a, 2008b, 2008c), Wells et al. (2008a, 2008b), and Cooke and Welch (2008a, 2008b), using standard indicators for injury, show that the annual injuries to the river system and the lake were growing after 1980 and will continue to grow until the spreading of poultry waste is stopped. Once that occurs, annual injuries will begin to decline. The injuries presented in the CV survey are those occurring after the spreading of poultry waste is stopped.

When comparing the indicators of injury in 1981-2008 against 2009-2063, the annual injuries to the river and lake are sometimes larger in the earlier period and sometimes smaller. Overall, the average annual injuries are approximately comparable between the two periods (J. Stevenson, G.D. Cooke, and E.B. Welch, personal communication, January 5, 2008).

Given that the average annual injuries between 1981 and 2008 are approximately the same as the average annual injuries between 2009 and 2063, the evaluation of injuries over the two periods then depends on the difference in the number of years and on the implicit discount rate used to aggregate injuries over the spans of time involved. As noted above, respondents to the CV survey may have acted as if they assessed the change in the injuries in terms of a discounted present value using their personal inter-temporal rate of time preference. And, if so, different respondents may have used different inter-temporal discount rates. Table 1 presents a sensitivity analysis for a variety of discount rates, including 0% (i.e., no discounting), 1%, 2%, 3%, 7%, 15%, and 25%. The table compares the present values of two streams of injuries: the present value as of 1980 of a stream consisting of one unit of annual injuries occurring between 1981 and 2008, and the

**Table 1. Comparison of present values of past versus future injuries**

<b>Discount rate</b>	<b>Present value in 1980 of stream from 1981 to 2008 (A)</b>	<b>Present value in 2008 of stream from 2009 to 2063 (B)</b>	<b>Ratio (A/B)</b>
0%	28.0	55.0	0.51
1%	24.32	42.15	0.58
2%	21.28	33.17	0.64
3%	18.76	26.77	0.70
7%	12.14	13.94	0.87
15%	6.53	6.66	0.98
25%	3.99	4.0	1.00

present value as of 2008 of a stream consisting of the same one unit of annual injuries occurring between 2009 and 2063.<sup>1</sup> With a discount rate of 2%, the present value of the injuries as of 1980 is 64% of the present value of the injuries as of 2008. Two percent is a modest discount rate, and we employ it as a conservative estimate.

Accordingly, based on the benefits transfer, had Oklahoma households made an evaluation in 1980 of the future loss of services from injuries in the Illinois River system and Tenkiller Lake occurring during the period 1981-2008, they would have valued it at about \$118.11 per household in 2008 dollars (64% of \$184.55).

Two other factors need to be considered. The first is the difference in real incomes between 1980 and 2008. Since we intend to express the value of the 1980 natural resource damages in 2008 dollars and we are conducting a benefit transfer from an estimate presented in 2008 dollars, what matters for an economic adjustment of WTP is the change in real income (i.e., income after adjusting for inflation) per household in Oklahoma between 1980 and 2008, measured in 2008 dollars.

Table 2 shows the median real household income in Oklahoma between 1980 and 2007, the most recent year for which information is available from the US Census Bureau. The nominal (1979) dollars reported by the Census Bureau are converted in 2008 dollars using the Consumer Price Index (Bureau of Labor Statistics, 2009). Real median household income in Oklahoma has changed very little over this period – in fact, it is now somewhat lower than it was in 1980. Therefore, the WTP estimate from 2008 should be adjusted upwards to account for the slightly higher real income in 1980. However, since the change was so small, to be conservative we make no adjustment for this increase in real household income.

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1. The formulas used for the calculations in the table are given in the appendix.

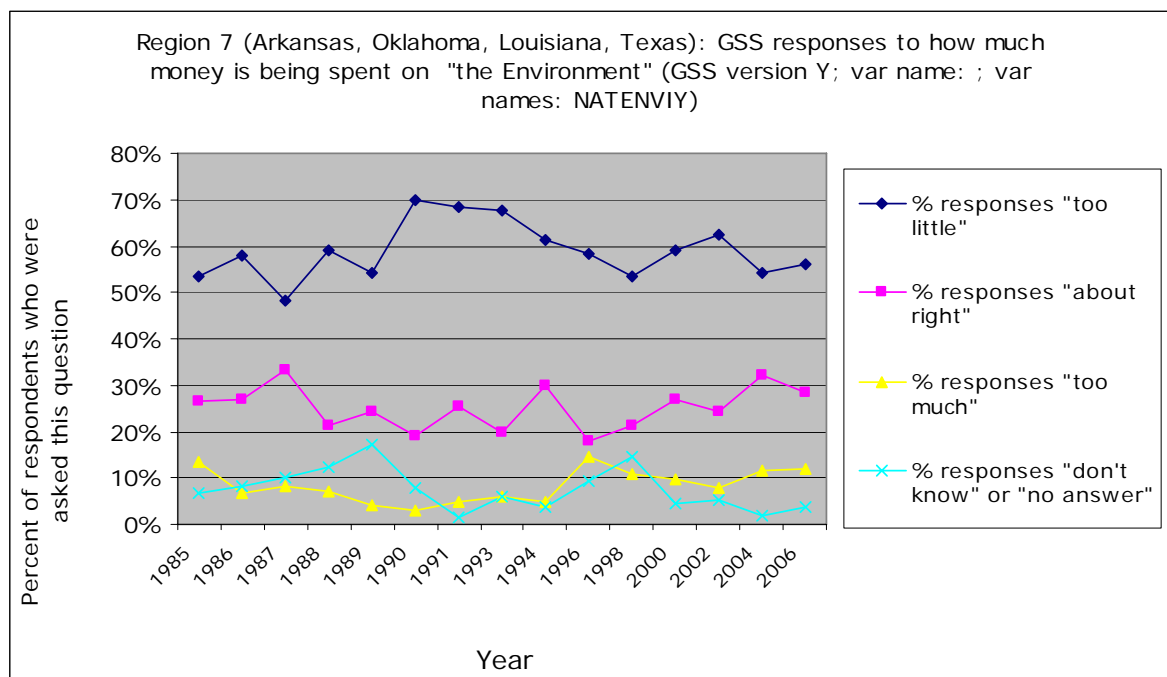
**Table 2. Oklahoma median real household income, 1980 to 2007 (2007\$)**

1980	1990	2000	2007
\$40,819	\$38,880	\$41,309	\$40,371

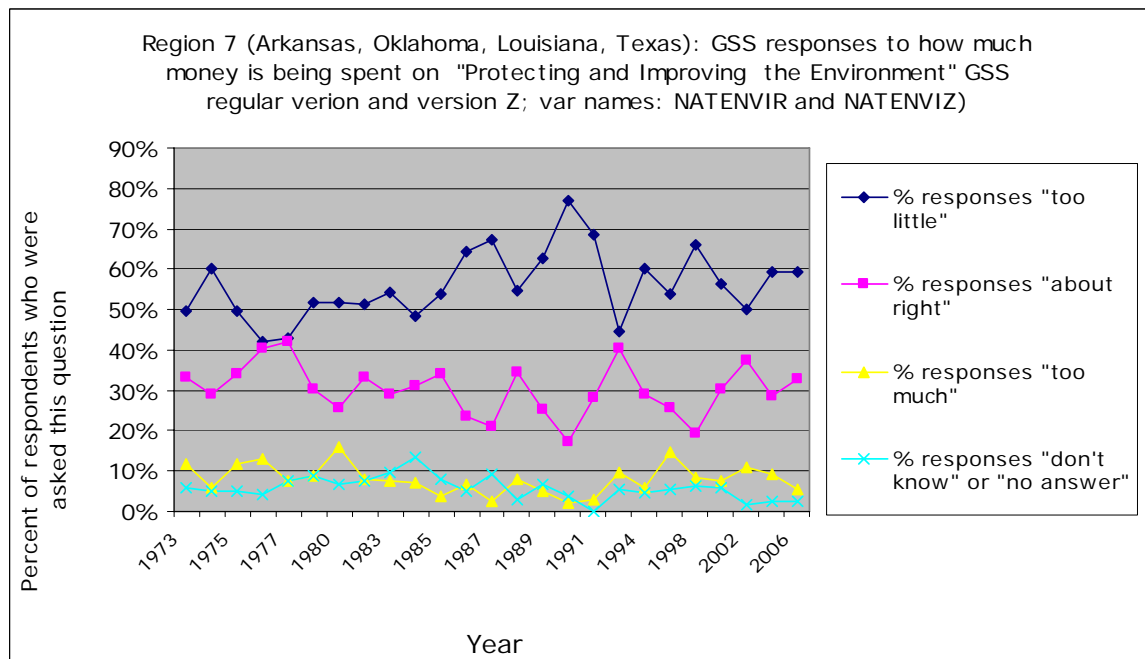
Sources: 1979 data (U.S. Census Bureau, 1983); 1990 data (U.S. Census Bureau, 1993); 2000 data (U.S. Census Bureau, 2003); 2007 data (U.S. Census Bureau, 2005-2007).

Another factor to consider is changes in attitudes towards spending money on the environment between 1980 and 2008. To gauge whether attitudes toward spending money on the environment have changed over this period, we use indicators from the General Social Survey (GSS), administered by the National Opinion Research Center, Chicago, Illinois, which is a data-collection program designed to monitor trends in social change within the United States. Since the 1970s, the GSS has included two versions of a question on environmental attitudes. One question asked about how much money is being spent on “Protecting and Improving the Environment.” The other version asked about money being spent on “the Environment.” In both cases, the response categories were “too little,” “about right,” “too much,” and “don’t know” or “no answer.” Figures 1 and 2 show how the responses to these questions varied between the late 1970s and now for region 7, which includes Oklahoma. While there has been some fluctuation in the responses, overall the responses are about the same now as they were in 1980. There is no evidence of a material change in attitudes towards spending money on the environment that warrants an adjustment to the estimate of value obtained for Oklahoma public trust resources in 2008 when it is adapted to 1980.

Accordingly, based on evaluation of potential adjustments, the best estimate of the total value placed, in 1980, on the injuries to Oklahoma public trust resources in the Illinois River system and Tenkiller Lake during the period 1981-2008 is \$118.11 per household, in 2008 dollars.



**Figure 1. General social survey – spending on “the environment.”**



**Figure 2. General social survey – spending on “protecting and improving the environment.”**